EG&G RETICON

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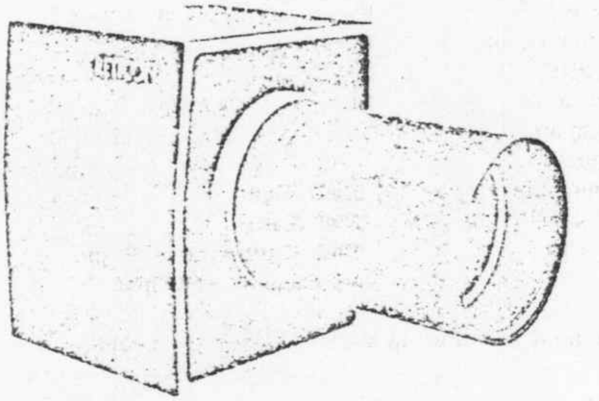
MC520 100x100 MATRIX CAMERA/RS520 CONTROLLER



The RETICON Model MC520 100 x 100 Matrix Camera features an advanced solid state photodiode array having excellent uniformity, smooth spectral response, and low blooming characteristics.

KEY FEATURES

- Pixel scan rate .25 to 5 MHz, 25 to 500 frames/sec
- 200: 1 dynamic range
- Sampled and held video output signal
- 100% solid-state construction
- 10,000 pixels in a 100 x 100 matrix
- Non-burning, low blooming photosensor
- High reliability environmentally sealed enclosure
- Interchangeable "C" mount lenses with optional protective lens cover
- Superior uniformity
- Low impedance differential line driver outputs
- Camera may be separated up to 75 feet from controller or user's equipment

GENERAL DESCRIPTION

The MC520 is used typically in applications for non-contact measurements, pattern recognition, laser instrumentation, and military guidance. Functionally, it is similar to a vidicon camera except that the sensor has been replaced with a solid state photodiode array matrix having 10,000 pixels. By means of a lens, the camera can look at any square field of view with an x-y dimension of a fraction of an inch to several feet. The image formed on the photodiode array is scanned electronically to produce a sampled-and-held video output signal. The amplitude of each pixel is proportional to the incident light intensity integrated over the interval of one frame period.

The camera can be operated as a "stand alone" sensor. It may be connected to the user's equipment with a suitable interface, or, with the RS520 Controller.

The controller provides D. C. power, master timing, video signal processing, presettable video threshold level for binary digital output, and x, y, z, display monitor drive signals.

ELECTRONIC CONFIGURATION

Camera operation requires the RS520 Controller or D.C. power and x-y clock inputs from the user's equipment. The camera contains three printed circuit boards to provide the following functions:

(1) Generates array driving waveforms from the x and y input clock signals.

(2) Processes the array video signal to provide a differential low impedance output.

(3) Regenerates synchronizing signals with differential low impedance outputs.

SENSOR ELEMENT

The MC520 camera is supplied with a Reticon RA 100 x 100 Array. The array contains a matrix of 10,000 discrete silicon photodiodes arranged with 2.4 mil (60 um) center to center spacing. The camera may be ordered with a blemish-free photodiode array (RA 100 x 100-1), or with an array having up to 9 inoperative elements (RA 100 x 100-2).

BLOOMING CHARACTERISTICS

Figure 3 shows the RA 100 x 100 array blooming characteristics. These measurements were made by illuminating an area in the center of the array approximately 10 x 10 pixels. The effect of excess illumination, expressed as a percentage of photosensor saturation, is then examined at a line approximately 15 lines from the edge of the illumination area. For example, if the 10 x 10 pixel area is illuminated at two times the photodiode saturation level, the blooming will be typically 5%. A photodiode outside the illuminated area, therefore, may produce an error signal of 5% of its saturated output.

ELECTRONIC CONFIGURATION

The MC520 Camera is enclosed in a cast aluminum housing 3.58 × 3.8 × 3.75 inches, exluding lens and connector extensions. The camera is designed for industrial environments and with the optional lens cover, it becomes sealed against dust. The camera is threaded for a universal lens mount and with an included adapter, it will accept any standard "C" mount lens. The camera may be specified with a through-the-lens viewer (V-mount) which is threaded for U-mount lenses.

MC520 INPUT/OUTPUT PIN ASSIGNMENTS

Signal	Pin	Function
Internal Connection	A	
Camera Clock Out+	B	
Camera Clock Out-	C	
Internal Connection	D	
+15V @ 150 ma. in	E	
Analog GND	F	
Video Out (+)	G	50Ω differential
Video Out (-)	H	line driver up to 2V pp, AC coupled
Digital GND	J	
End of Frame (+)	K	
nd of Frame (-)	L	

Signal	Pin	Function
M Clock in (+)	M	X Clock in
M Clock in (-)	N	
M1Clock in (+)	P	Y Clock in
-15V @ 100 ma. in	R	
Analog GND	S	
M1 Clock in (-)	U	Y Clock in
+5V @ 250 ma. in	T	
Test Signals		
Frame Sync	BNC (Right)	
Line Sync	BNC (Left)	
Video TP	BNC (Center) up to 2V pp. AC coupled, white pos.	

(All outputs will drive up to 75 ft. transmission cable)

RS520 CAMERA CONTROLLER

When used with the MC520 camera, the RS520 controller will provide the following functions:

(1) Power and synchronizing clock signals for the camera.

(2) Additional camera video processing:

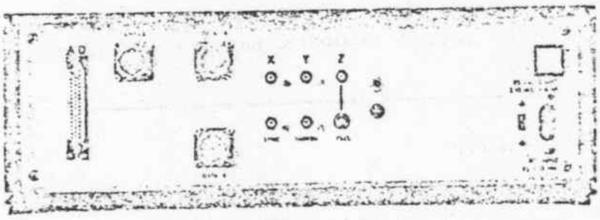
- a. re-sample and hold for improved signal/noise
- b. D. C. restoration and blanking insertion
- c. differential low impedance (75Ω) video output

(3) x, y and z low impedance drive signals for an external video monitor (50Ω).

(4) Adjustable video threshold to produce bi-level digital video.

(5) Output synchronizing signals for additional cameras, user interfacing equipment, and RS8500 controller.

) An optional plug compatible board can be installed into the RS520 to provide 6 or 8 bit digitization.



BNC Connectors:

X- 50Ω±1V X-Axis monitor sweep
Y- 50Ω±1V Y-Axis monitor sweep
Z- 50Ω monitor video, 0 (Black) to 1V pp (White)
Sync- 50Ω Oscilloscope frame sync
Thresh.- 10 KΩ Oscilloscope monitoring of threshold level
75Ω TWINAX connector -0 to 2V pp differential video for driving up to 100 ft Twinax cable (not to be used simultaneously with 50Ω Data B video output)
BANANA JACKS - update input

RS 520 Data B Connector

Signal	Pin	Function
CNTRL	A	False per one frame per negative transition (switch closure) of update input.
LEN Out+	B	Line enable false at end of pixel
LEN Out-	C	100; true at beginning of pixel 1
Analog GND	E	
Video GND	F	Shield GND for 50Ω differential video
Video Out+	G	0 (black) to +2V (peak white),
Video Out-	H	50Ω differential.
Digital GND	J	
Digital GND	T	
		D.C. restoration interval; goes true
Re-Ref.+	K	at end of pixel 100, goes false two
Re-Ref.-	L	clock intervals prior to pixel 1
H clk+	M	Continuous clock out at pixel rate
H clk-	N	
		Camera slave out; goes true at
(M6. EOF)+	P	beginning of pixel 99, goes false at end
(M6. EOF)-	U	of pixel 100.

RS 520 Data A Connector

Signal	Pin	Function
Digital GND	A	
E-clk In+	E	External clock in to synchronize
E-clk In-	F	camera
Data Out-	G	Thresholded video; binary video
Data Out+	H	true for pixels above threshold
Light Level Indicator-	K	Latches true for entire line or frame when one or more pixels exceed a
Light Level Indicator+	L	preset threshold
G clk Out+	M	Pixel rate clock, switch selectable
G clk Out-	N	for continuous or gated mode
FEN Out+	P	Frame enable true at beginning of
FEN Out-	U	pixel 1, line 1; false at end of pixel 100, line 100
E-Start+	S	External input
E-Start-	R	to initiate start of scan

OPTICAL RELATIONSHIPS

The selction of the proper lens and magnification combination is selected to produce the required working distance and system resolution. Figure 1 can be used when the magnification is known to determine the proper lens for the desired working distance. The following formulas can be used to determine magnification and resolution:

$$\text{Object Magnification} = \frac{\text{Linear Field Size (inches)}}{0.24 \text{ inches}}$$

$$\text{Resolution} = \text{Object Magnification} \times .0024 \text{ inches}$$

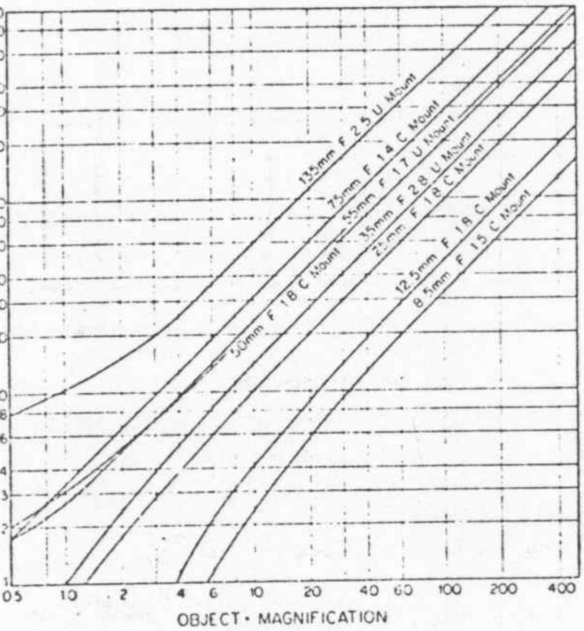


Figure 1. Lens selection chart.

Note:

the C-mount lenses, only the 50 and 75 mm can be used with the through-the-lens viewer. Use the 50-mm C-mount lens and viewer for object magnifications of 1.5 or less. Use the 75-mm C-mount lens and viewer for object magnifications of 2 or less.

Lens Extenders. These items are used to extend the focusing range of lenses for close-up use (object magnifications below 10 or 15). Lens extenders are used behined the lens to increase the lens-to-image distance because the focusing range of most lenses is approximately 5 to 10 percent of the focal lenght. The lens extension for any application can be calculated from the following formula:

$$\text{Lens Extension} = \frac{\text{Focal length}}{\text{Object Magnification}}$$

The lens extender kit for C-mount lenses includes shims for small extensions. The support for the non viewer U-mount lens includes an 8-mm adjustment which is built in, and which bridges the gap to the minimum 12-mm lens extension tube.

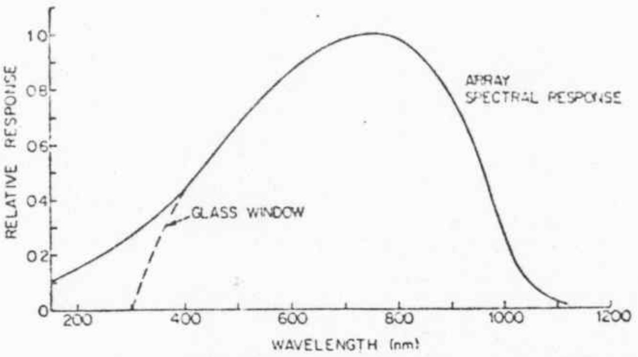


Figure 2. Relative spectral response.

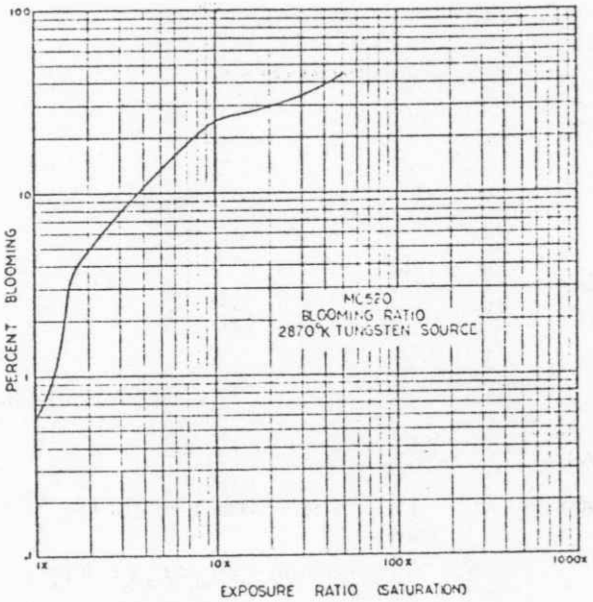


Figure 3. Blooming Chart.

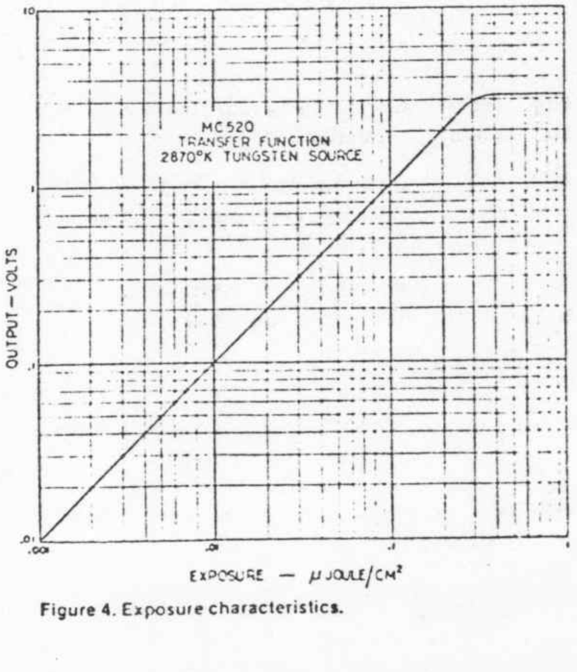
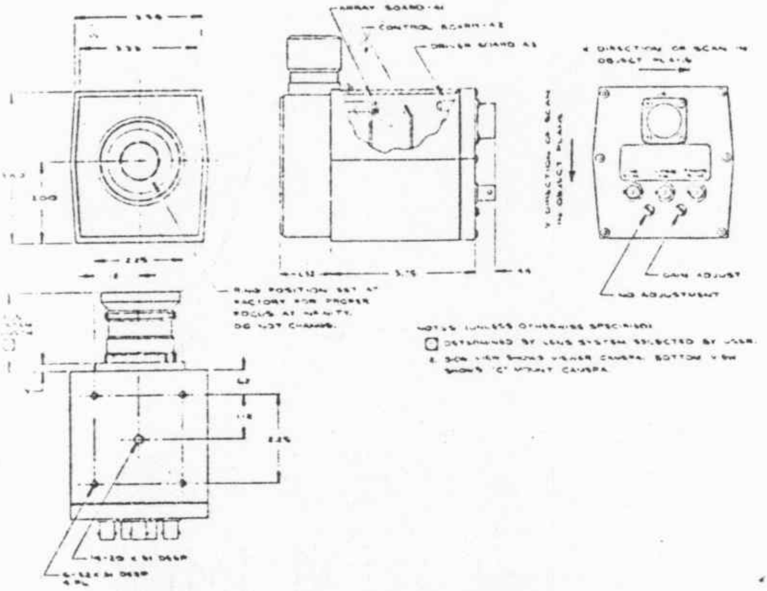
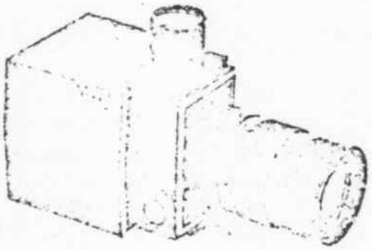


Figure 4. Exposure characteristics.

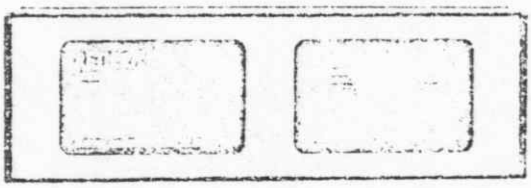
(2870° K Tungsten source measured using a detector with flat response and 370 to 1040 nm bandwidth)


ARRAY BOARD A1
CONTROL BOARD A2
DRIVER BOARD A3
X DIRECTION OF SCAN IN OBJECT PLANE
Y DIRECTION OF SCAN IN OBJECT PLANE
2.25
1.00
3.75
2.25
RING POSITION SET AT FACTORY FOR PROPER FOCUS AT INFINITY. DO NOT CHANGE.
GAIN ADJUST
NO ADJUSTMENT
NOTES: (UNLESS OTHERWISE SPECIFIED)
DETERMINED BY LENS SYSTEM SELECTED BY USER.
SIDE VIEW SHOWS VIEWER CAMERA, BOTTOM VIEW SHOWS "C" MOUNT CAMERA.

MC520 mechanical configuration



MC520 with "V" viewer



RS520 controller

ORDERING INFORMATION:

CAMERAS:

MC520C100X100-1	Matrix Camera with belimish-free array
-2**	Signifies array with up to 9 defective elements
U*	Signifies universal mount lens
V*	Signifies through the lens viewer ("U" Lens Thread)

*LENS:

CX100-8.5C, -12.5C, -25C, -50C, or -75C.	8.5 mm to 75 mm focal length "C" mount lenses.
†CX100-35U, -50U, -135U	35 mm to 135 mm focal length universal mount lenses. Other sizes available on special order.
†CX381-44	4X microscope lens system
†CX381-1010	10X microscope lens system

*LENS ACCESSORIES:

CX331	"U" to "C" Adapter (included on MC520C cameras)
CX300	"C" mount lens extender kit
†CX320	"U" mount lens extender kit

**Available at reduced cost
*Optional equipment
†Requires "U" mount camera.

*SEALED LENS HOOD:
(Not available for viewer option)

CX200C	—1.75 (for CX100-8.5C and -25C lens) —2.75 (for CX100-12.5C and -50C lens) —4.5 (for CX100-75C lens)
†CX200U	—3.4 (for CX100-35U lens) —4.45 (for CX100-50U lens) —5.45 (for CX100-135U lens)

CONTROLLER & ACCESSORIES:

RS520	Matrix camera controller including power supply
*RS520-A	Controller with rack mount
*RSB5206	6 Bit Video Digitizer
*RSB5208	8 Bit Video Digitizer
*RS502-8	Standard 8 ft. cable (included with controller). Special lengths up to 75 ft. available.

Camera with RS520 controller is compatible with Reticon RS600 and RS8500 series controllers and RSB Camera/Microcomputer Interface Boards.

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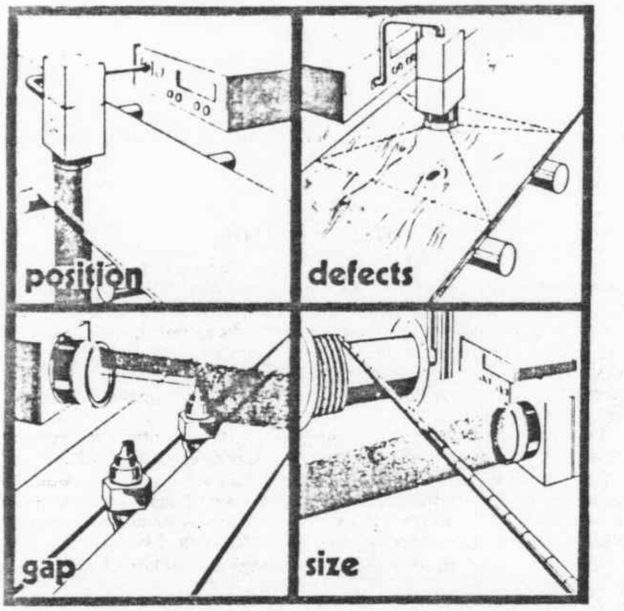
RETICON® CAMERA AND SYSTEMS PRODUCT SUMMARY



RETICON Solid-State Imaging Cameras are used for rapid, accurate, non-contact measurements of size, position, and shape, and for the detection of surface defects to facilitate the automatic control of manufacturing processes. They offer the precision, reliability, and drift-free characteristics of a totally solid state and digitally controlled electro-optical system. Typical applications include: inspection and edge control of webs such as textile, paper, hot or cold glass and steel strips; sorting of high-volume parts by dimensional analysis and pattern recognition; control of size of continuously formed or expanded materials. Solid-state imaging cameras are functionally similar to vidicon type TV cameras, but with the added advantages of greater geometric accuracy, extended spectral range, higher sensitivity and scan rates, digital output, small size, low voltage and power requirements, and the ruggedness and reliability of solid-state design.

Imaging cameras operate similarly to photographic cameras except that a RETICON Solid-State Image Sensor replaces the film plane. Both linear and two-dimensional (matrix) arrays of photo-sensitive elements are available in addition to a complete line of appropriate optics and camera accessories. Four basic camera models are offered in different physical configurations and output formats to enable users to select the optimum camera system for each application.

Fields of view range from a fraction of an inch to several feet, depending on the optics selected. The camera lens projects the field of view on the image sensor which is scanned electronically to produce a train of analog pulses. The pulse outputs are proportional in amplitude to the light intensity on the corresponding photosensitive element. These pulses are then thresholded and digitized within the camera for further processing by any standard RETICON RS600 Series Electronic Controller. These controllers can be programmed to display parameters such as edge position, object width, number of light-to-dark transitions per scan for code reading or surface condition, etc. Custom controllers, including microcomputer-based systems, have been designed by RETICON to meet a wide variety of special requirements.

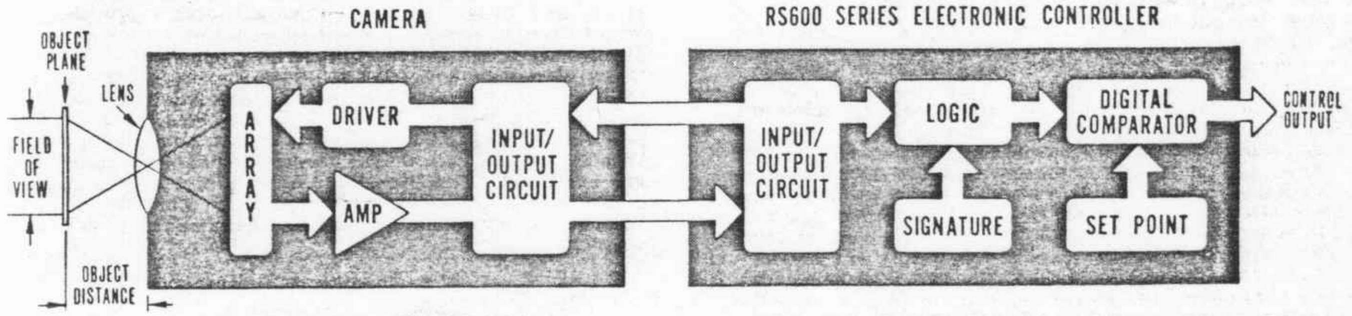


Figure 1. Typical camera-controller system diagram.

THE SOLID STATE IMAGE SENSOR

All RETICON cameras are based on a solid state image sensor also developed and manufactured by RETICON. A simplified schematic diagram of a typical such image sensor is shown in Fig. 2.

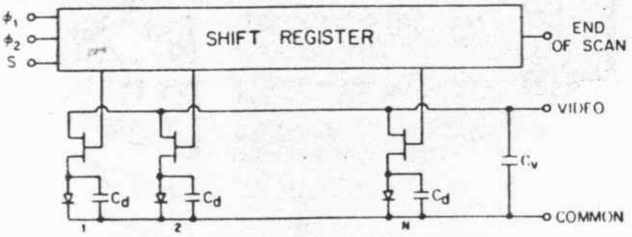


Figure 2. Simplified Schematic diagram of typical line scanner

The shift register is driven by a clock; each scan is initiated by a start pulse. The start pulse loads a bit which is clocked through the register, successively opening and closing the switches and thus connecting each photodiode, in turn, to the video line. As each photodiode is accessed, its capacitance is charged to the potential of the video line and is left open-circuited until the next scan. During the interval between scans, the capacitor is discharged by an amount equal to the instantaneous photocurrent in the diode, integrated over the line scan. Each time a diode is sampled, this integrated charge loss must be replaced through the video line. The resulting video signal is a train of charge pulses, each proportional in magnitude to the light intensity falling on the corresponding photodiode.

The total number of photodiodes in a single linear array ranges from 64 to 1024; two-dimensional matrix arrays are available in 32x32, 50x50, and 100x100 element configurations. The clock and start requirements for matrix arrays are similar to those for linear arrays; the output is on a single video line.

The sensitivity and spectral response of RETICON arrays are equivalent to high-quality discrete silicon photodiodes generally used between 400 and 1100 nanometers, and cover the entire visible and part of the IR spectrum.

THE LC-600 LINE SCAN CAMERA

The RETICON LC600 Solid State Line Scan Camera is available with standard arrays ranging from 64 to 1024 resolution elements with center-to-center spacing as small as 1 mil (25.4 microns). Seven standard lenses and three standard array aperture widths are available.

The camera output is developed from a comparison of

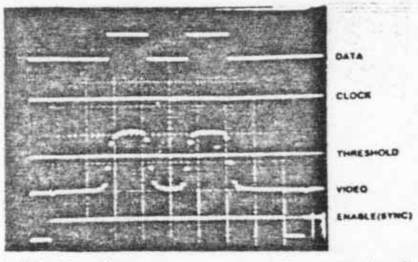


Figure 3. Outputs of line scan camera scanning across two light bars on a dark background.

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RETICON CAMERA AND SYSTEMS PRODUCT SUMMARY

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analog pulse train from the array with an electronically adjustable and preset threshold level as shown in Fig. 3. A digital output of logical ZERO results from light values below the threshold — dark — and a logical ONE level for light values above the threshold — light. Timing information is provided on separate differential output lines for use by the remote controller to correlate the output data with the position of each diode in the array, and includes a series of digital clock pulses synchronized to the diode sampling process and a data enable output. The data enable line becomes active when the first photodiode in the array is sampled, and remains active until the last diode is sampled, it notifies the controller that valid data are being transmitted. All data lines appear on differential line drivers at TTL level to facilitate long data lines and noise immunity.

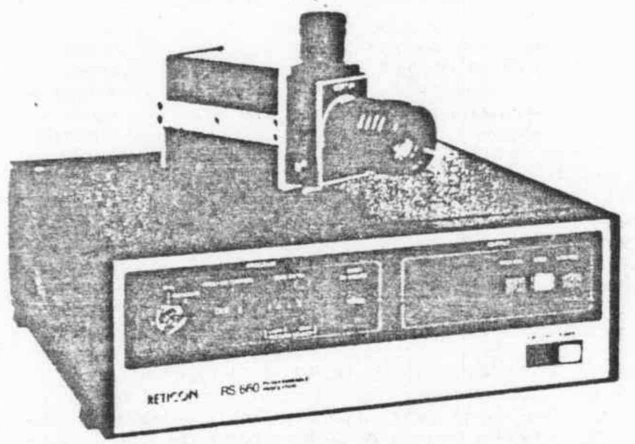


Figure 4. LC600V Camera (through-the-lens viewer) with T-mount lens, and RS660 Programmable Processor.

The user can easily set the element-to-element sampling rate or the total time between initiation of each line scan, based on the specific needs of each application. Instructions for the optimum setting are available from RETICON, as it depends on the available light level, the contrast between light and dark areas, the linear or rotational velocity of the viewed object, and similar factors. Scan rates are adjustable from 5 KHz to 1.05 MHz, representing from 128μsec to 40 msec required to complete a total line scan (depending on the array length).

The digital outputs can be processed by standard RETICON RS600 series control systems, or by user-supplied controllers or process computers. Control of the camera, for most applications, is entirely internal to the camera. However, the camera will respond to external clock and start pulses. The user may elect to supply either or both of these control inputs so that both the element-to-element sampling rate and the line scan times are externally controlled. The camera requires only a ±15 volt and +5 volt power supply at less than 4.2 watts of total power, also furnished by the RETICON RS600 series controllers. If a customer-supplied processor is used, supplemental power supplies should be planned which are also available from RETICON.

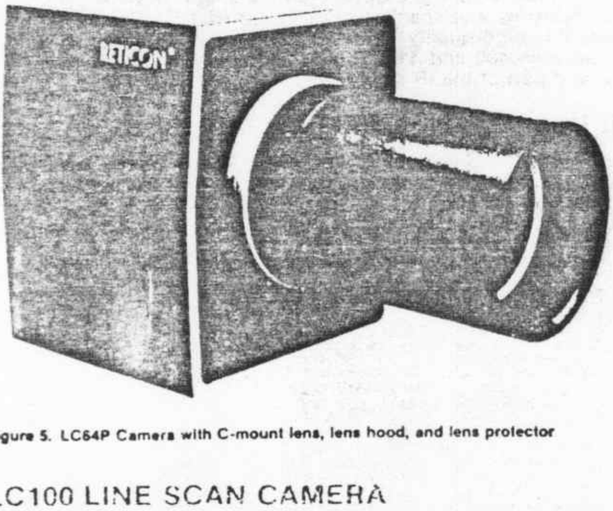


Figure 5. LC64P Camera with C-mount lens, lens hood, and lens protector

LC100 LINE SCAN CAMERA

The RETICON LC100 Line Scan Camera is physically identical to the LC600 camera and offers the same high degree of flexibility, but is designed for applications requiring higher scan rates and further remote processing of the analog video. These cameras can be operated at scan rates from 2 KHz to 2 MHz, representing total line scan times from 64μsec to 40msec. The LC100 provides improved dynamic range and sampled-and-held boxcar analog output in addition to the corresponding thresholded digital output of the LC600 camera. Both analog and digital outputs are brought out on differential line drivers to provide stable and noise-free data transmission over longer cable lengths between the camera and the RS600 series controllers or other user-furnished equipment. The higher quality analog output allows multiple-bit digitizing of this signal for computer inputs. The LC100 is recommended primarily where either this type of A/D conversion or clock rates in excess of 1 MHz is required.

LC64P LINE SCAN CAMERA

The RETICON LC64P Line Scan Camera is a lower-cost, lower-resolution, and simplified version of the widely used LC-600 series camera. It is available in a single configuration using a 64-element photodiode array, with center-to-center spacing of 2 mils. The analog video output from the array is connected to a BNC connector on the rear panel, and is a "boxcar" type waveform at 0 to 1.5 volts in amplitude, with "dark noise" typically less than 10 mv.

The LC64P is built in a rugged, cast aluminum housing; it provides the same outputs as the LC600 camera and is compatible with all the lens and other accessories offered for that camera except the through-the-lens viewer. Power requirements are ±15 volts d.c. at less than 5 watts. The camera is compatible with all RETICON RS600 Series Controllers. The LC64P is recommended for applications where 64 elements of resolution are sufficient, and where the low cost of this camera is a major consideration.

MC500 SERIES MATRIX CAMERAS

RETICON MC500 Series Two-Dimensional Cameras are available with matrix arrays of either 100x100, 50x50, or 32x32 elements. The cameras can operate at clock rates up to 500 KHz, corresponding to 500 frames/sec for the 32x32, 200 frames/sec for the 50x50, and 50 frames/sec for the 100x100 element array. These cameras are available with various options providing an analog "boxcar" output, a digital thresholded output, or both. The analog output can be digitized by a remote A/D converter to furnish multiple grey level definition. The digital camera contains an internally adjustable threshold which can be set to generate TTL level digital data from the video similar to that provided by the LC600 series line cameras. Applications of the MC500 Series Camera include character recognition, code reading, checking of concentricity of rotating objects, and general dimensional analysis of at least momentarily stationary objects. The cameras are compatible with RETICON RS510 series power supplies.

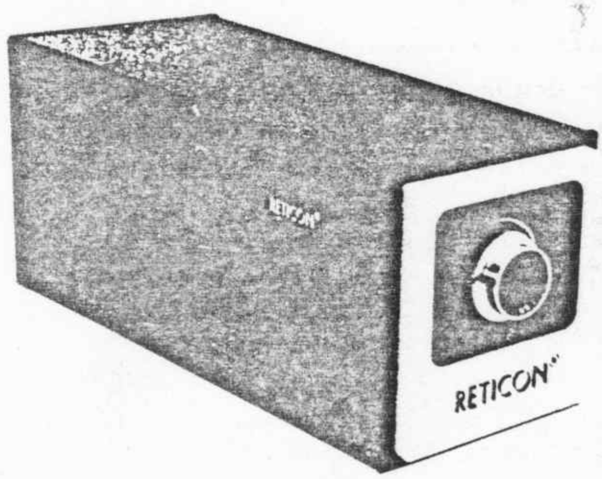


Figure 6. LCD-200 Camera with special lens mount to accept Leica-threaded lenses

SPECIAL-PURPOSE CAMERA

LCD-200 Dual array Camera. This special purpose camera uses two optically superimposed arrays to color scan at two specific wavelength bands. Infrared is used as the reference because it is insensitive to color; the visual spectrum is used to detect color changes. The outputs of the two arrays are compared on an element-by-element basis. When the ratio of signal levels between the two arrays exceeds preset limits, an error ignal is provided. The LCD-200 is particularly effective in selection, sorting, and orientation of food products where blemishes and discoloration must be detected. The LCD-200 eliminates the need for background or reference color comparators used in conventional color scanners. The LCD-200 may be used with RETICON RS600 Series controllers; its output signals are compatible with computers and electro-mechanical sorting devices.

CAMERA CONTROL MODULES

The RS600 series controllers are designed to interface with RETICON line scan cameras to provide a complete non-contact measurement or inspection system. Through a connecting cable these modules supply power to the camera and accept the camera outputs for processing and display. Depending on the specific model chosen, the controllers give an indication that the light level is adequate, provide for selection of the pattern within the camera field of view which is to be measured and give both a digital display of the measurement and a corresponding BCD output for further processing.

Various standard options are available which provide for go-no go testing to preset limits or tolerances, automatic sorting into up to 10 categories, direct teletype printout of the measured data, display in engineering units (e.g., inches, millimeters, etc.), area measurements of irregular size objects, the retention of maximum and minimum dimensions, the addition of constants to allow the use of the camera as a vernier when small variations of a large dimension are of interest, self calibration, analog output for process control, and various package configurations (e.g., NEMA-12, 19" rack mount, etc.).

The RS600 provides power to RETICON Line Scan Cameras, and presents the camera outputs on a terminal strip.

The RS605 contains counting circuits as well as power supplies. It converts the camera output into a continuously updated count which represents a size or position measurement. The controllers can be set to measure a dark object against a light background or vice versa, or to count light-to-dark transitions, such as threads on machined parts or holes.

The RS610 can control two cameras—either separately or in conjunction—to measure two edges of a large object. A thumbwheel-switch signature control enables any portion of a complex pattern to be measured.

The RS660 contains a microcomputer which can be used to perform further arithmetic manipulations on the raw data, and will in addition to the various features and options available with the RS605 and RS610 provides direct TTY interface.

The RS510 Power Supply Module is used with the MC500 matrix cameras. It provides power and presents the x, y, and z outputs of matrix cameras on BNC connectors for a CRT display.

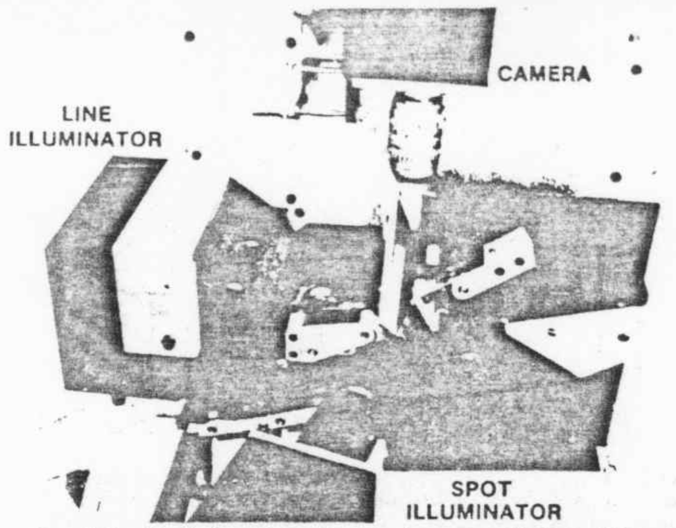


Figure 7. Special roller inspection system, showing camera with C-mount lens and line and spot illuminators

ILLUMINATION SOURCES AND OPTICS

Illumination Sources. Illumination sources play important roles in all RETICON systems. Lighting systems compatible with solid-state image sensors are available from RETICON, or can be designed readily for most applications. Three standard RETICON illumination systems offer front lighting (reflection) or back-lighting (shadow) of objects ranging in size from a fraction of an inch up to eleven inches. All use quartz-iodide lamps and forced air cooling. In most applications the units can be operated at reduced voltages for thousands of hours of lamp life.

In many applications, the objects to be measured can be illuminated by available fluorescent light, incandescent light, or the object itself may have sufficient luminescence such as hot-rolled or extruded steel or molten glass.

Optics. RETICON also offers a complete line of standard C-mount, T-mount, and custom optics for use with all camera models. Accessories are provided such as lens protectors, lens extenders, threaded adapters, optically clear windows, etc. A through-the-lens viewer is also available to permit visual alignment of the object and the camera optics when no image display is available.

STANDARD CAMERA CONFIGURATIONS

MODEL	LENS MOUNTING	RESOLUTION ELEMENTS	ELEMENT SPACING (MILS)	APERTURE WIDTH (MILS)	LINE (FRAME) SCAN TIME* MIN	MAX
LC64P	C	64	2	2	0.4msec	40msec
LC600	C, T, V	64	2 or 5	2 or 3	64μsec	40msec
LC100	C, T, V	128, 256, 512	2	1 or 6 or 17	64μsec	40msec
LC600	C, T, V	128, 256, 512	2	1 or 6 or 17	128μsec	40msec
LC100	C, T, V	256, 512, 768, 1024	1	1 or 6 or 17	128μsec	40msec
LC600	C, T, V	256, 512, 768, 1024	1	1 or 6 or 17	256 μsec	40msec
MC500	C, T, V	32x32, 50x50, 100x100	4	—	2 msec	40 msec

*Scan rate depends on the number of resolution elements per array. For the LC600 camera, N μsec to 40 msec, for the LC100 camera N/2 μsec to 40 msec, for the MC500 cameras, 2N μsec to 40 msec (where N is the number of resolution elements).

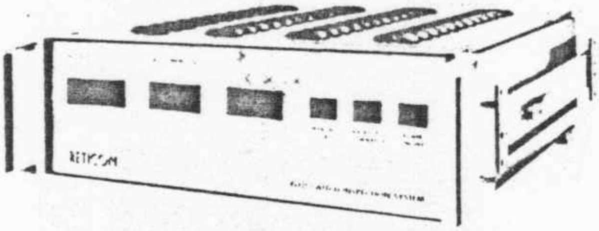
In order to simplify the identification of RETICON cameras, the following system is used to specify the camera configuration:

Line Camera (MC-Matrix Camera)
Style (64P, 100, 500)
Lens Mounting ("C" or "T" Mount, "V" indicates Reflex Viewer)
LC600 T 1024-1/17
Aperture Width (Mils)
Element Spacing (Mils)
Number of Elements (64 to 1024 and 32x32, 50x50, 100x100)

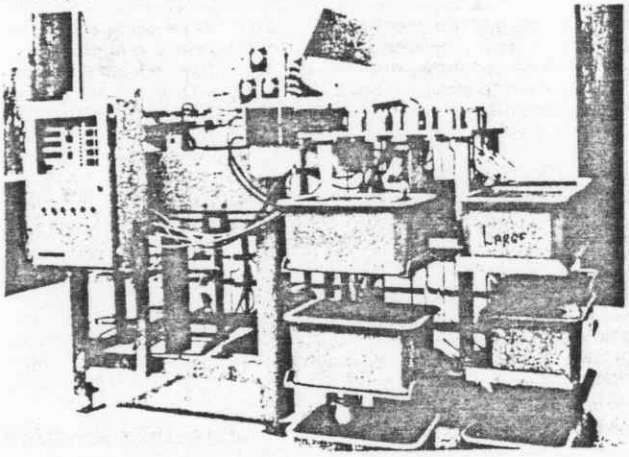
CUSTOM-DESIGNED SYSTEMS

Although most measurement applications can generally be handled by one or more standard cameras and controllers, there are still many instances where custom engineering is required. As an example, visual inspection applications in which the controller must recognize specific defects may require the design of a custom system.

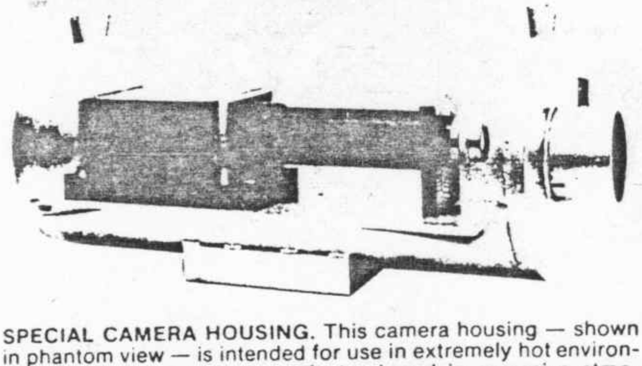
Standard RETICON line scan cameras and light sources, in conjunction with a custom processor are used in the following applications.



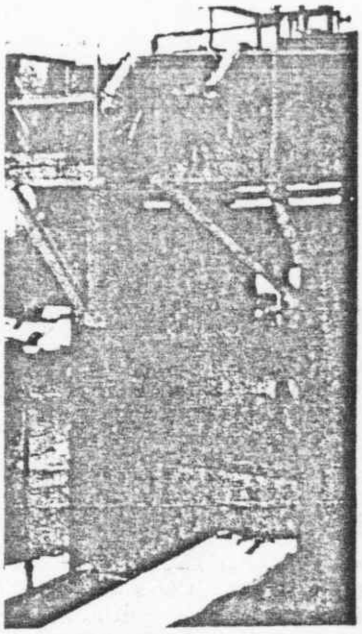
REED SWITCH LEAD CONCENTRICITY TESTER. In this system, two MC500 series matrix cameras are used to simultaneously measure the concentricity of the two axial leads of reed switches. The switches are rotated around the longitudinal axis, with the leads back illuminated and the shadows imaged on the matrix cameras. The custom controller — housed in a standard 19-inch rack cabinet with adapters — displays the length and concentricity of the leads. The computer-compatible output is designed to interface with the user's automatic manufacturing and inspection equipment.



PLASTIC MOLDING INSPECTION SYSTEM. This integrated system consists of a rotating conveyer, a two-camera inspection station, an electronic processor, and a classification/sorter. The two RETICON cameras measure the volume of a plastic syringe barrel and sort them into eleven acceptable dimensional groups and two rejection categories, automatically and at a rate of 500 items/minute. A NEMA 12 housed controller displays the inspection results and permits classification criteria to be changed by thumbwheel operation. It also provides a continuous count of the accepted parts by categories which are set up to classify parts to an accuracy of 0.001 inch.

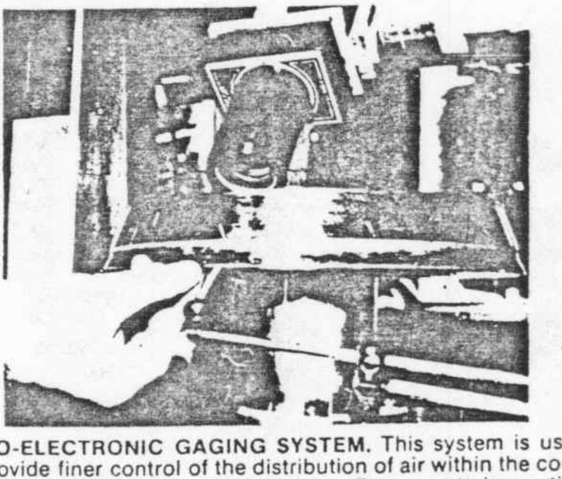


SPECIAL CAMERA HOUSING. This camera housing — shown in phantom view — is intended for use in extremely hot environments (steel and glass manufacture) and in corrosive atmospheres. The outer casing is made of stainless steel, the housing is water jacketed for cooling, and an air purged viewing window is provided.



HOT STRIP MEASUREMENT SYSTEMS (RS880 SERIES). These systems are designed for continuous and accurate monitoring of the width of hot-rolled steel and glass ribbons in float glass manufacturing plants. Two completely solid-state cameras are provided within rugged water-cooled stainless steel enclosures with air purged windows. These assemblies are mounted above the hot strips where the cameras make use of the available radiation of the hot strip or can be provided with back illumination for the measurement of colder objects.

The associated controllers are housed in a NEMA 12 enclosure, and provide continuous digital readout of the strip width, as well as computer interface for automated mills. Many standard display and control options are available to meet specific mill requirements. Monitoring stations with continuous display can be mounted along side the rolling line with the master processor located near other controls. System accuracy of better than $\frac{1}{16}$ inch provides increased manufacturing efficiency with payback typically less than a year.



OPTO-ELECTRONIC GAGING SYSTEM. This system is used to provide finer control of the distribution of air within the combustion chamber of jet aircraft engines. By accurate inspection of the holes around the outside flanges of the combustion cooling rings, Rolls Royce has been able to achieve a more even distribution of air and produce an engine which is cleaner, more reliable, and more efficient. The RETICON system is used to gage the size and position of these holes (as many as 4,000 — 0.020 inch in diameter) and, with the help of a micro-computer and printer, is able to provide information of hole area and distribution which is related directly to engine performance. Note the through-the-lens viewer for easy alignment of the camera to accommodate different flange diameters.

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35100 PADOVA - Via Turazza, 32/41
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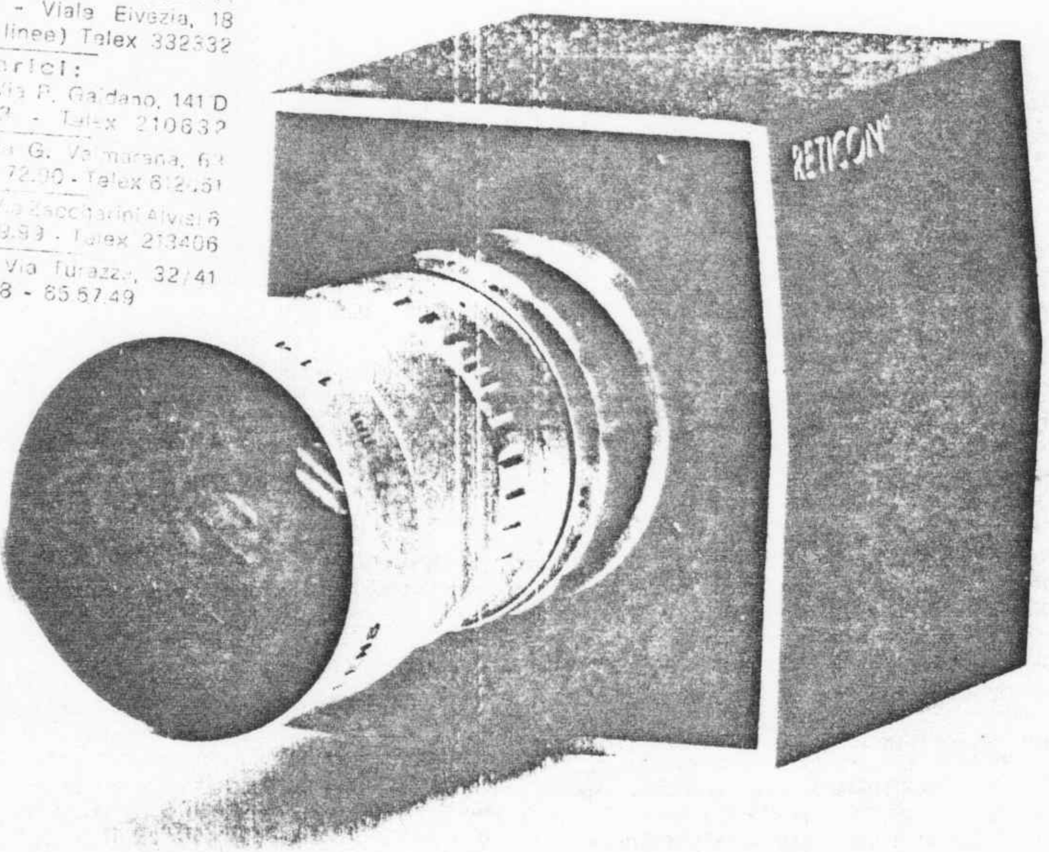
LC300 Series Line Scan Industrial Instrumentation Camera



Solid state image-sensing cameras for non-contact measurement and pattern recognition . . . in robotics and factory automation applications.

EG&G RETICON
WHERE VISION AND TECHNOLOGY MEET

129.10.

The newest line scan camera from Reticon. 12 as automotive, lumber, electronics, food proce bottles and glass. . . . .

FEATURES

- **100% Solid State Design**
- **Non-burning Image Sensor**
- **Sealed Industrial Case**
- **Interchangeable "C" or "U" Mount Lenses**

LC300 Series Line Scan Cameras use a linear photodiode array as the image sensor. The camera also contains the array driver circuits, clock, and I/O differential line driver outputs for communicating with various standard Reticon computer interface modules, or your particular image processor.

Reticon photodiode arrays are miniature DIP packaged monolithic integrated circuits which convert incident light energy to electrical video output signals. The video signal amplitude is proportional to the light intensity integrated over the exposure time. These light-sensitive image sensors respond to the near portion of the ultra-violet spectrum, the entire visible spectrum, and into the infra-red (see Fig. 1). Photodiode arrays are functionally compared to vidicon (TV) tubes; however, they offer the added advantages of: greater geometric accuracy, broader spectral response, higher scan rates, smaller size, as well as low voltage and power requirements, and solid-state ruggedness and reliability.

The LC300 camera is available with any of four linear photodiode arrays, ranging in resolution from 128 to 1,024 pixels. Pixels are in a single straight line with center-to-center spacing equal to 25 microns. The width or aperture of the light-sensitive line of pixels is 25 microns. An optional higher sensitivity aperture width equal to 250 microns is also available in all LC300 Series cameras.

Functional Description

The photodiode array in the LC300 Camera is designed for continuous scanning applications. The array is scanned by a clock which switches from pixel to pixel at an adjustable frequency (f). After clocking the last pixel in the array, there is an adjustable blanking period before repeating subsequent scans. The length of the blanking period ranges from eight (8) clock periods minimum to four thousand and ninety six (4,096). Accordingly, the line scan time (LST), or integration time, for the array is described as LST = count/f, where "count" equals the number of array pixels, plus the blanking time divided by the clock frequency in hertz. A potentiometer, accessible from the camera rear panel, can be used to adjust the frequency (f) over a range of 50 to 500KH$_Z$.

A single-ended video output signal is available at one of three rear panel BNC connectors. It is a sample-and-held "boxcar" type waveform suitable for digitizing. The signal level is from zero to + 1.0 volts amplitude when connected into a 100 ohm load.

A second BNC connector, allows convenient monitoring and adjustment of the camera threshold level. The threshold circuit functions as a comparator to provide conversion of the analog video signal to a black/white digital binary data signal. A potentiometer, accessible from the rear panel, permits adjustment from zero throughout the analog video voltage range. When the video signal exceeds the threshold value, the digital data output will go high or to a logical "1" state. Conversely, when the video drops below the threshold value, the digital data will go low or to a logical "0" state.

The third BNC connector provides a TTL signal for synchronizing an oscilloscope when monitoring the video output signal. The sync signal level is low, or logical "0", during scan and high, or logical "1", during the blanking period.

An enable output signal provides synchronization when taking data into an external buffer or video processor. The enable logic level is high, or logic level "I", when scanning the array and low, or logic level "0", during the blanking period. The enable signal, data and clock is available for external connection via the eighteen pin connector located on the rear of the camera.

The LC300 camera can also be clocked and thus synchronized by an external supplied clock signal. Although timing of the external clock is not critical, the signal must be generated as a differential output meeting E.I.A. Standard RS-422 Specifications.

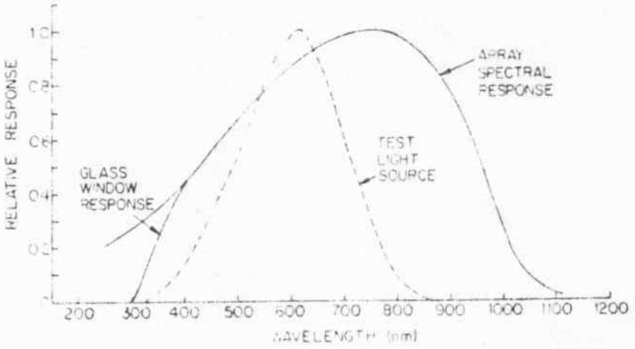


Figure 1. Relative spectral response as a function of wavelength. Response of the glass window is similar to the quartz window as shown above.

1024 pixel resolution for use in industries such ing, pharmaceutical, rubber and plastics,

- **Thresholded Binary Output**
- **Wide Dynamic Range Analog Video Output**

Sensitivity and Spectral Response

The image sensor spectral response is similiar to that of other high-quality silicon photodetectors, covering the range from the UV to the near IR. Note that relatively high responsivity is maintained even in the blue end of the spectrum because there is no interfering structure covering the diode. As most applications for these devices utilize visible light, the sensitivity and uniformity of response are specified using a source with the spectral distribution shown by the dotted line in Fig. 1. This spectral distribution is produced by filtering a 2870°K tungsten source with a Fish-Schurman HA-11 heat absorbing filter 1 mm thick.

Mechanical

The LC300 Line Scan Camera is enclosed in a cast aluminum housing measuring 3.58" x 3.5", excluding lens and connector extensions. Input and output connectors are on the rear of the camera and consist of an eighteen (18) pin MS3112 type connector and 3 BNC test points. The camera assembly can be mounted by using four (4) 6-32 tapped holes on a 2.25" square pattern at the bottom of the unit. Also available is a 1/4-20 threaded hole for mounting to a standard photographic tripod.

- **Compatible with Multibus™ and Q-Bus™ Processors**

Power Supplies and Computer Interface Products

Reticon model RS series power supplies and standard computer interface modules are compatible with the LC300 series line scan camera. The RS600B power supply is available in a bench top model and NEMA-12 rated version (RS600Y). Two computer interface modules are available for plugging directly into a multibus™ (model RSB6020) or Q-bus™ (model RSB6320) main frame. Call your nearest sales office listed on the rear page for additional information on these and other Reticon image processing products.

Optical

A "C" mount lens adaptor is supplied with cameras when ordered with image sensors containing 128, 256 or 512 pixels. A "U" mount lens adaptor is provided when ordering the camera with 1024 pixels. Standard photographic lenses available for use with both the "C" mount and the "U" mount arrangement are available directly from Reticon.

SIGNAL	PIN
GROUND	A
+ 15 volts	B
− 15 volts	C
+ Data	H
− Data	G
+ Enable	P
− Enable	U
+ Clock	N
− Clock	M

Table 1. Connector Pin Assignments

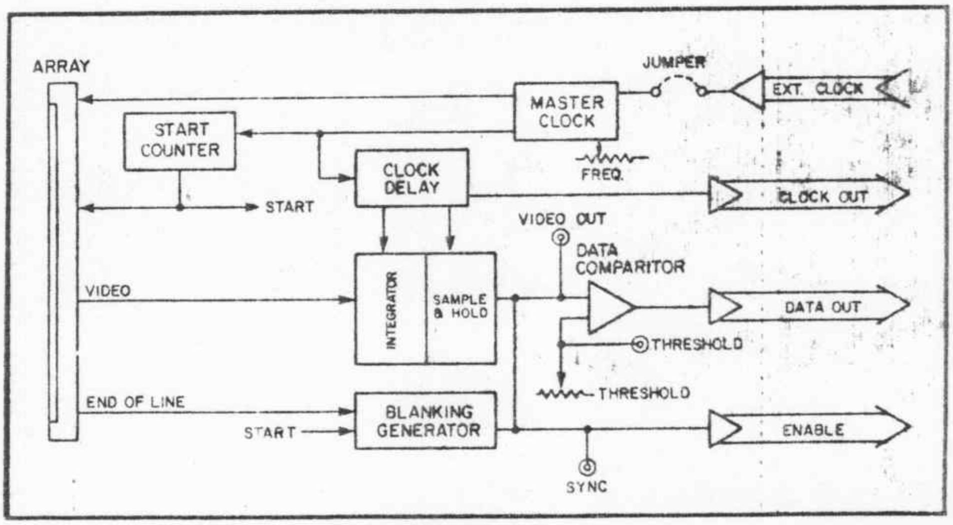


Figure 2. Camera Block Diagram

™Multibus is a trademark of Intel Corporation.

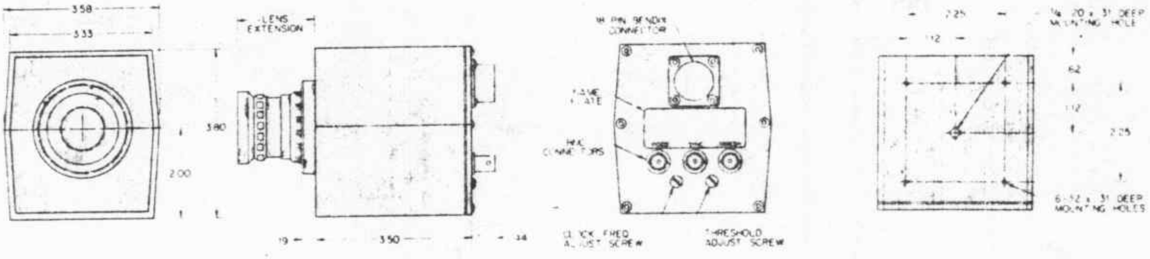
™Q-Bus is a trademark of Digital Equipment Corporation.

LC300 Camera Specifications

Electrical	Power Requirements	± 15 VDC, ± 5% @ 100 ma ± 5VDC, ± 5% @ 400 ma
	Clock Frequency	
	Internal	50 Khz - 500 Khz adjustable
	External	50 Khz - 500 Khz requires 100 ns minimum pulse width from type 9638 or equivalent line driver.
Array	128, 256, 512, 1024 pixels	(Reticon G Series array data sheet available upon request)
	Line Scan Time (Max.)	40 milli-seconds
	Line Scan Time (Min.)	
	128 pixel array	256 micro-seconds
	256 pixel array	512 micro-seconds
	512 pixel array	1.0 milli-seconds
	1024 pixel array	2.0 milli-seconds
	Scan Rate (lines per second)	
	128 pixel array	3906 max.
	256 pixel array	1953 max.
	512 pixel array	975 max.
	1024 pixel array	488 max.
	Digital Outputs	(TTL compatible via 9638/9637 differential line driver/receiver)
	Data	Output of video comparator
	Enable	Logical "1" during line scan Logical "0" during blanking
	Clock Pulse Width	Nominally 700 ns
	Video Output	
	Saturated	+1 Volt with 100 ohm load-wait-sample-and-hold (single-ended) (+2 volt open circuit)
	Dark Level	20 MVPP max. at 500 KHz clock rate (excluding first two and last two pixels). At 40 ms line scan time and 25°C room ambient, dark level less than 4% of saturated output.
Temperature and Humidity Range		0-40°C operating, 90% RH non-condensing (see dark level specification)
Mechanical	Case	Cast aluminum 3.58 x 3.8 x 3.5 inches, excluding lens and connector extensions.
	Mounting (bottom)	Four 6 x 32 tapped holes on 2.25 inch square pattern. Also 1/4 x 20 tapped tripod mounting hole.
	Weight (less lens)	1.5 lbs.
	Connectors	18 pin, type MS3112

ORDERING INFORMATION

The LC300 camera part number includes a code description of the camera housing, lens mount and sensor options, LC300 (camera); C (mount); 256 (sensor): LC300C128-1; LC300C256-1; LC300C512-1; LC300U1024-1. The user may also specify the line scan time. If it is not specified, it will be set at the factory as described under ELECTRICAL.



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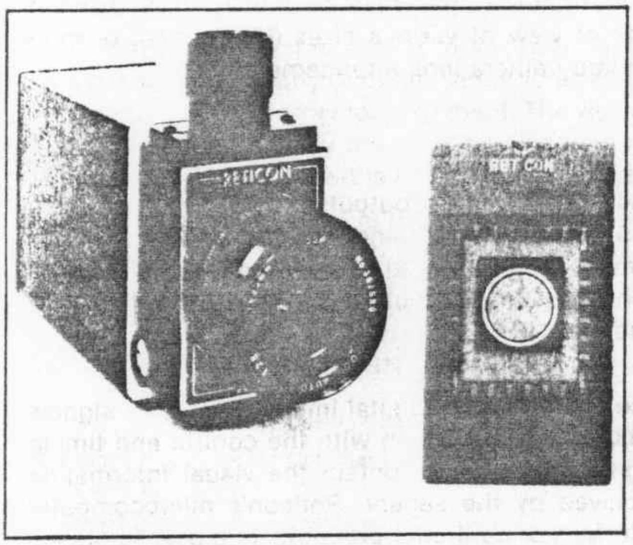
EG&G RETICON

MODEL CC130 CIRCULAR SCAN CAMERA



The CC130V720 Circular Scan Camera and the RO720B circular photodiode array.

The Reticon Model CC130 Circular Scan Camera, utilizing a unique Reticon RO720B Circular Array, is ideally suited for automating circular scanning applications. Reading repetitive measurement, location, pattern recognition and general inspection tasks are based on visual object information existing along a circular 'scan' line. An example of this concept is sensing position and movement of a dial.

The key features of the unique EG&G Reticon Model CC130 Circular Scan Camera* are as follows:

- **100% solid state design**
- **360 degrees circular scan line**
- **Resolution of 0.5 degrees, 720 elements**
- **25 to 250 scans per second**
- **Analog sample & hold**
- **Threshold (black/white) digital data output**
- **Thru-lens-viewer and alignment reticle**
- **Industrial configuration**
- **Availability standard control electronics**

---

* Reticon also offers other cameras with up to 2048 elements in a line and up to 65,536 elements in a square matrix, and a wide range of other standard photodiode array devices.

GENERAL DESCRIPTION

The Model CC130 is a rugged, reliable, solid state image sensor device circular scan camera. It is designed for use as a geometrically precise remote non-contact vision sensor instrument, which when coupled with an appropriate video data processor will perform repetitive measurement, positioning, pattern recognition, and inspection tasks.

The camera's sensor receives visual information in the same manner as does a film type camera. In this case however, the image plane is a ring of photo sensitive silicon with 720 sensing elements (pixels) spaced at 0.5 degree increments over the 'length' of the ring. The camera's field of view is, accordingly, a ring of proportionally sized dimensions dictated by the optical magnification as provided by an appropriate lens assembly. This field of view is imaged onto the photodiode array which is electronically scanned at rates up to 250 times per second to produce a sampled-and-held analog video output. Each complete scan consists of a series of 720 pixel amplitudes, with the level of each pixel being directly proportional to the light level intensity received by the corresponding photodiode sensing element on the ring structure. This analog signal is provided as an output, and is also conditioned internally by (user selectable) two threshold level circuits to provide two bi-level (black/white) digital outputs.

Aside from the analog and digital video output signals, the camera accepts and outputs various control and timing signals, and operates 'stand alone' with +5 and −15 voltage inputs. Internal differential signal line drivers and receivers provide a camera input/output interface to remote data processing electronics at distances up to a hundred feet.

SENSOR DEVICE

The CC130 Camera is supplied with a Reticon RO720B Photodiode Circular Array. This monolithic integrated circuit contains a contiguous photosensitive circular 'line' of 720 sensor elements, at 0.5 degree spacing. The inside radius of the circular array is 3.45 mm, and the outside radius is 3.65 mm. At the inside radius, the center-to-center spacing is approximately 30μm.

Accordingly, the image plane is an annular ring of an inside diameter of 6.90 mm (appx. 0.272 mils) and an outside diameter of 7.30 mm (appx. 0.287 mils). Object fields of view of various sizes (less, equal, or more diameter) can be imaged onto the array by the use of standard camera lens arrangements.

ELECTRONIC CONFIGURATION

The CC130 Circular Scan Camera requires a +5 volt and −15 volt input for operation which may be provided by a Reticon or user furnished power supply or controller.

By means of internal rocker switches, the user may either select internal or external clock and internal or external start operation. The internal clock may be set at any frequency within the Camera's operating range of approximately 20 to 200 KHz which corresponds to a circular scan rate of from nominally 25 to 250 samples per second- with either internal or external start.

The minimum internal (start) delay between scans is 56 clocks; when external start is used a minimum of 8 clocks between scans is required. In either case, the delay can be longer, with the maximum delay dictated by the minimum array scan rate of 25 scans per second.

The CC130 Camera outputs provided include clock and line enable timing outputs, video and two threshold video digital data outputs, and three BNC connector test outputs-video, line sync, and data threshold level.

The analog and/or digital image data video signals utilized in conjunction with the control and timing signals accurately contain the visual information received by the sensor. Reticon's microcomputer interface or controller products, or a user furnished unit, may be employed to accomplish the information analysis and processing task.

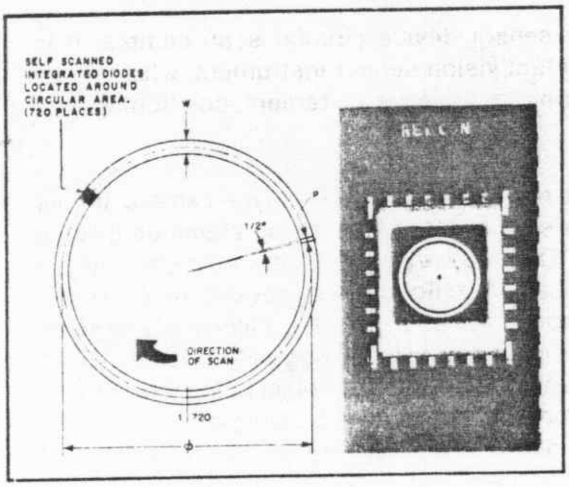

SELF SCANNED INTEGRATED DIODES LOCATED AROUND CIRCULAR AREA. (720 PLACES)
1/2°
DIRECTION OF SCAN
1
720
ϕ
RETICON

Fig. 1. Geometry of the Reticon RO720B Circular Array and Reticon RO720B Circular Array.

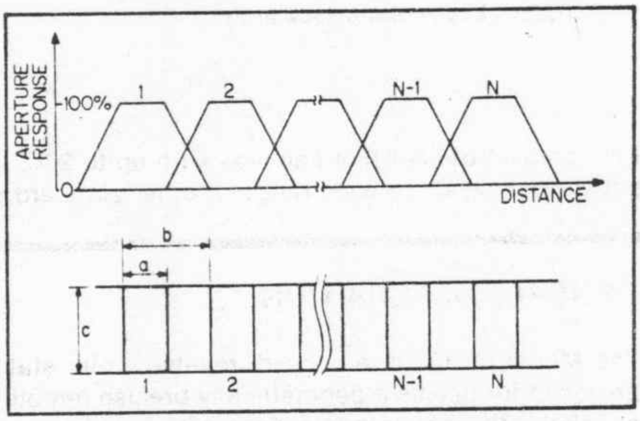


Fig. 2. Sensor Geometry (along circle) and Idealized Aperature Response

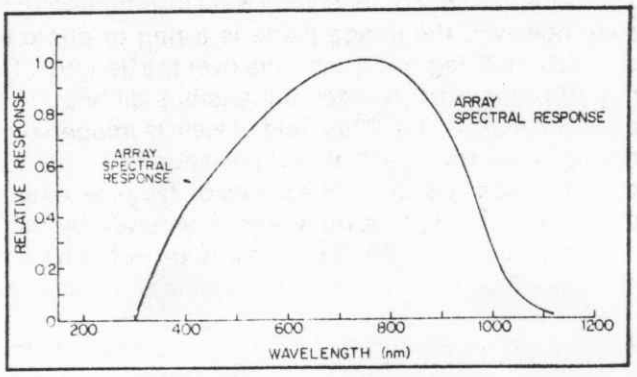


Fig. 3. Relative Spectral Response.

MECHANICAL CONFIGURATION

The CC130 Camera is available in one mechanical configuration, a Thru-Lens-Viewer Camera. The basic camera housing is shown in Figure 7. The camera body is 2.8 inches × 4 inches × 7.5 inches long (excluding lens and extension). A mounting bar, which is included, can be affixed to the bottom or either side of the camera. The camera also contains ruggedized mounting front and back plates, which contain sets of tapped 6-32 holes (4 sides). At the rear of the camera, the 18 Pin MS3112 Type Connector, three BNC Test/Set-up Signal Connectors, Clock Frequency and Threshold Level adjust screws are located.

The Thru-Lens-Viewer is similar to a viewer on a reflex type photographic camera; it enables the operator to see the subject directly through the camera lens. A reticle circle in the viewer shows the field of view location of the circular scan array for alignment. The viewer mirror is positioned out of the optical path, when not being used for set-up, to allow the maximum energy transmission to the sensor, versus the use of a beam splitter approach. The Thru-Lens-Viewer mount is threaded to accept standard "U" mount lens and lens accessories.

The camera construction is ruggedized for industrial environments, similar to the popular industrial LC600 and LC100 Series Line Scan Cameras.

INPUT/OUTPUT PIN ASSIGNMENTS

Signal	*Pin*	*Description*
Ext Clock +	E	Optional Input
Ext Clock −	F	
Ext Start +	S	Optional Input
Ext Start −	R	
Clock Out +	N	Clock (ext or int) actually used to scan sensor array
Clock Out −	M	
Enable Out +	P	High during scan period
Enable Out −	U	
Light Level Out +	L	High when light level exceeds a preset level (can be used a 2nd data out.)
Light Level Out −	K	
Data Out +	H	Threshold black/white data. High when video is above preset threshold
Data Out −	G	
Video Out +	J	1-volt peak sampled-and-held analog video with 75:1 dynamic range
Video Out −	T	
+5 Volt Supply	D	620mA
−15 Volt Supply	C	250mA
Ground	A	

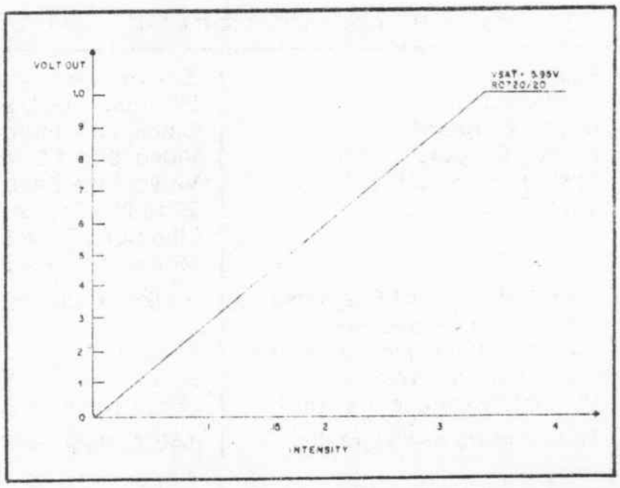


Fig. 4. Signal charge per cell as a function of exposure for light source of Figure 3.

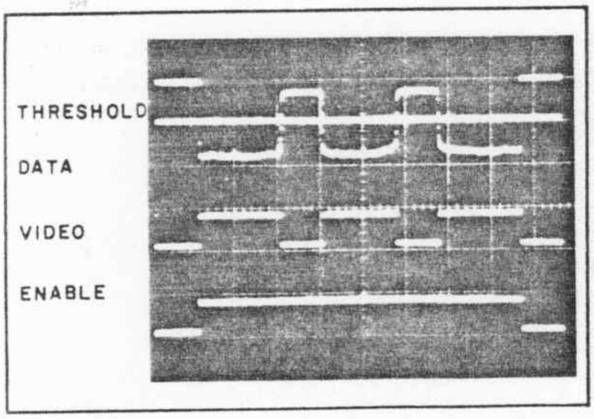


Fig. 5. Oscilloscope Photograph of CC130 Circular Camera Scanning across Two Crossed Dark Bars on a Light Background.

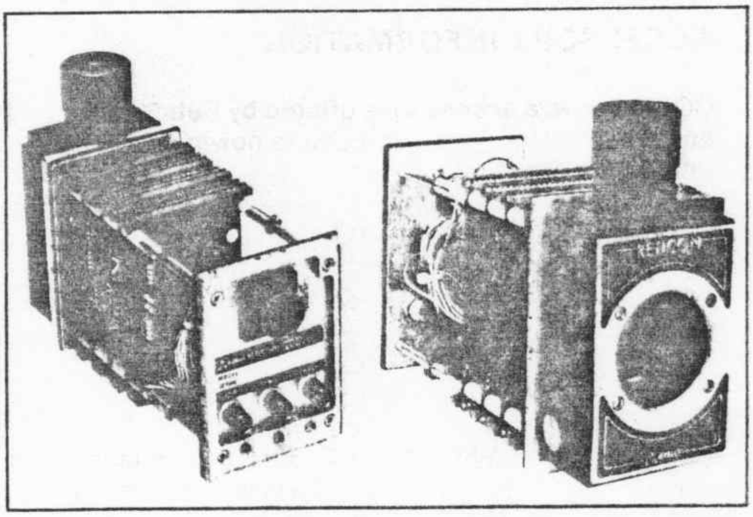


Fig. 6. Front and Rear Photographs of CC130 Camera with cover removed to show internal construction.

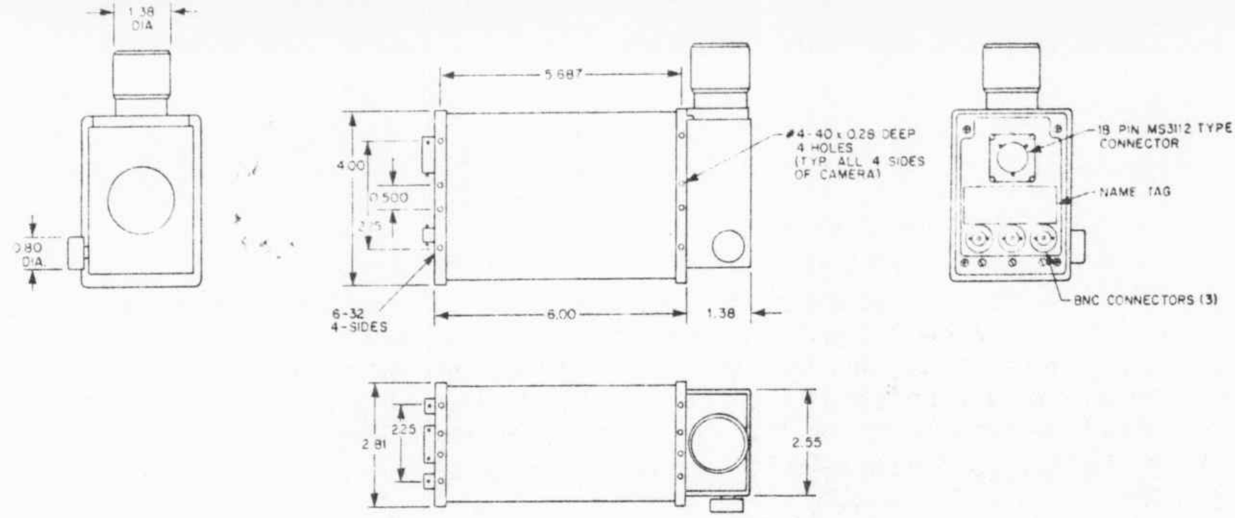


Fig. 7. Mechanical Outline of the CC130 Camera.

CC130V720B CAMERA SPECIFICATIONS

Power Inputs	5 +volts ±5% at 620 ma, −15 volts ±5% at 250 ma
Digital Inputs*	External Clock, External Start
Digital Outputs*	Clock, Line Enable, Data (Thresholded), and Light Level(Thresholded)
Analog Outputs*	Video, 0 to 1.0 volts (saturated)
Test Outputs (BNC)	Video, Line Enable, Data Threshold Voltage
Scan Rate	25 to 250 Scans per second Line Scan Time 0.04 to 0.004 seconds (successive scans) Minimum Delay Scan-to-Scan, Internal 56 clocks, External 8 clocks.
Non-Uniformity of Response (with HA-11 filtered light)	±15%, excluding first and last four elements
Random Noise, p/p (per pixel)	10mv
Fixed Pattern, p/p (max.)	30 mv
Dynamic Range (per scan)	25:1, saturation p/p noise
Temperature and Humidity	0-40°C, 90% RH Non-Condensing pounds
Weight	2 pounds 12 oz. (less lens)

* These inputs are differential line receivers and the outputs are differential line drivers to facilitate remote operation in excess of a hundred feet, if desired. A Reticon RS602 Type Camera Cable is recommended for this camera (a shielded twisted pair cable configuration).

ACCESSORY INFORMATION

CC130 Camera accessories offered by Reticon include lens and lens accessories, water cooled industrial environmental enclosures, camera power supplies and controllers, computer interfaces, and appropriate interface cables.

APPLICATION SUPPORT

With over 10 years of experience and over 5,000 systems in the field, Reticon can recommend the correct products and support them with expert technical experience.

TO ORDER

The Camera Model number CC13OV720 includes a code description of the camera housing and sensor. The user may also specify the line scan time. If it is not specified, it will be set at the factory as described under ELECTRONIC CONFIGURATION.

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EG&G RETICON

ADVANCE PRODUCT INFORMATION
MC9000 SERIES MODULAR SOLID STATE AREA CAMERA

The EG&G Reticon MC9128 is a miniature solid state area camera head incorporating a 128x128 photodiode array mounted directly onto a custom thick film hybrid microcircuit. Two hybrid microcircuits contain all the circuitry. The user need provide only a clock and power to the camera head to obtain video pixel streams at data rates above 8 megapixels per second. Additional differential lines provide the user with the means to activate a real time frame reset mode as well as a high speed row clocking mode.

Features

The MC9128 modular camera head provides a variety of operation modes, allowing the user ultimate flexibility in system configuration. The camera head is small enough, strong enough, and light enough to be used in robotic arm applications. The ruggedized body is designed to withstand wide heat ranges and shock from industrial settings.

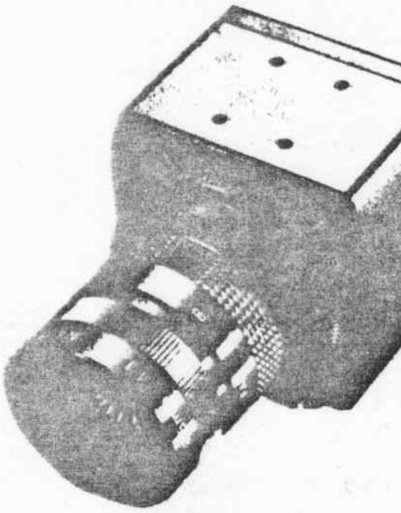

Figure 1. Front View

Functional Description

The matrix photodiode array in the MC9128 camera head consists of individual solid state photodiodes arranged in a square two dimensional pattern. The active area of the 128x128 photodiode image plane measures 302 mils on each side.

The photodiode array is self-scanning (in both the X and Y directions), so that the sensor requires only an X and Y clock. These clocks as well as other control signals are synthesized in a set of two thick film microcircuits inside the camera head.

In the camera's simplest mode of operation, a clock of up to 8 MHz in frequency may be input to the camera head. The circuitry in the camera head will then output differential video as well as differential synchronizing signals used to interface the camera to a video processor.

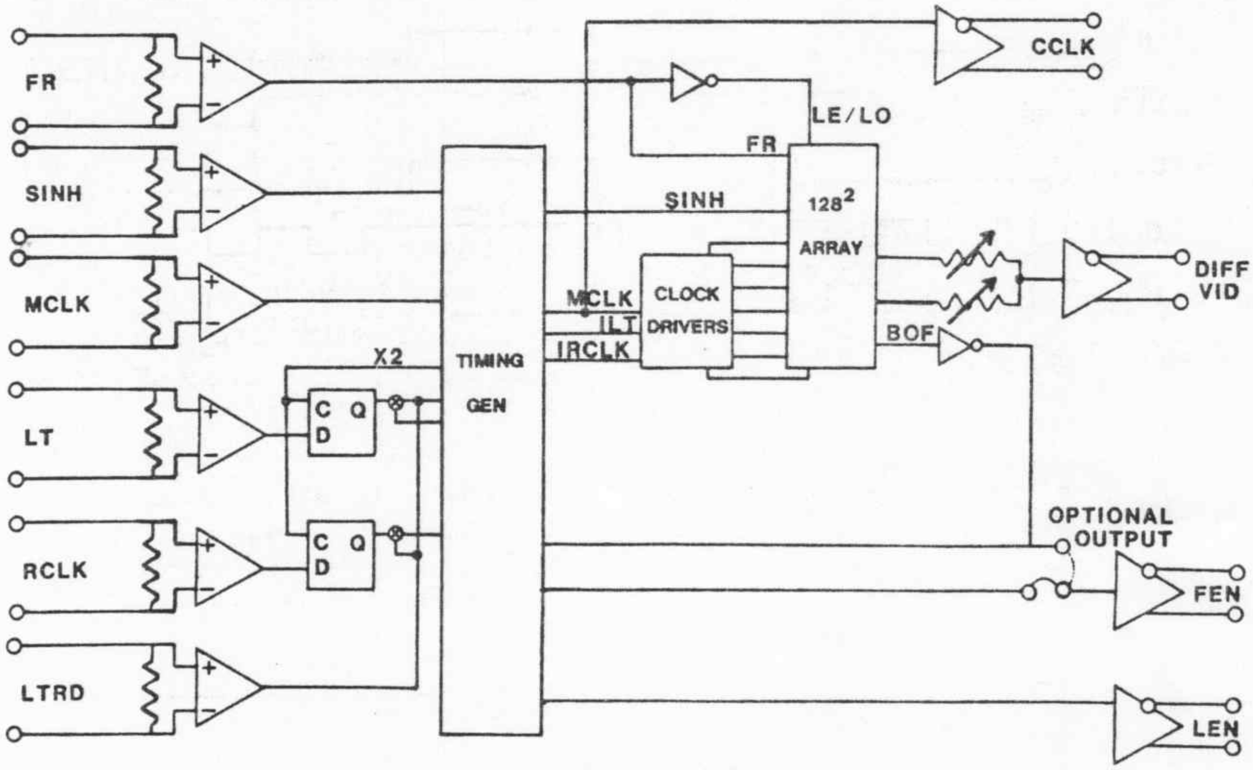

Figure 2. Block Diagram

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9128 Camera Head Specifications (preliminary)

Construction

The MC9128 modular camera head consists of two hybrid microcircuits sandwiched between an aluminum heat sink. The Reticon matrix array is bonded to the front hybrid. A flexible printed circuit directs the signals to a case mounted D subminiature connector. This type of ruggedized construction allows the MC9128 camera head to survive operating temperatures 0° to 50°C (baseplate temperature) and mechanical shocks to 10g's.

Optical

"C" mount lens adaptor standard. "L", "U", or Nikon Bayonet lens mount adaptors available.

Environmental

Shock: 10g

Vibration: 4g, sinusoidal over the range 5 Hz to 150 Hz

Temperature

Operating Range: 0 to 50° celsius (baseplate temperature)

Storage Range: -40 to 80° celsius

Shock: 10 cycles, 0 to 50° celsius

Electrical

Interface Connector	D Subminiature 25 pin	
Power Requirements	± 12 VDC ± 5% + 5 VBC + 5%	Approx. 5W
Clock Freq. (External)	524.8 KHz - 8 MHz	
Line Flyback Period (Internal)	36 Clock Cycles	
Video Output Saturated: (Differential)	± 1 V into 100 ohm load ± 2 V open circuit	
Video Output: Signal to Noise	Saturated to Peak-Peak Dark Pattern: ⩾100:1 Saturated to Random Pixel: ⩾1000:1	

Mechanical (Excluding lens and accessories)

Size: Length 1.45" (37 mm)
Width 2.5" (64 mm)
Height 2.5" (64 mm)

Mounting: Any of the six faces. Optional rotation bracket.

Weight: 12 ounces (340 grams)

Only MCLK is required for minimum camera operation. Other I/O required when using additional camera features.

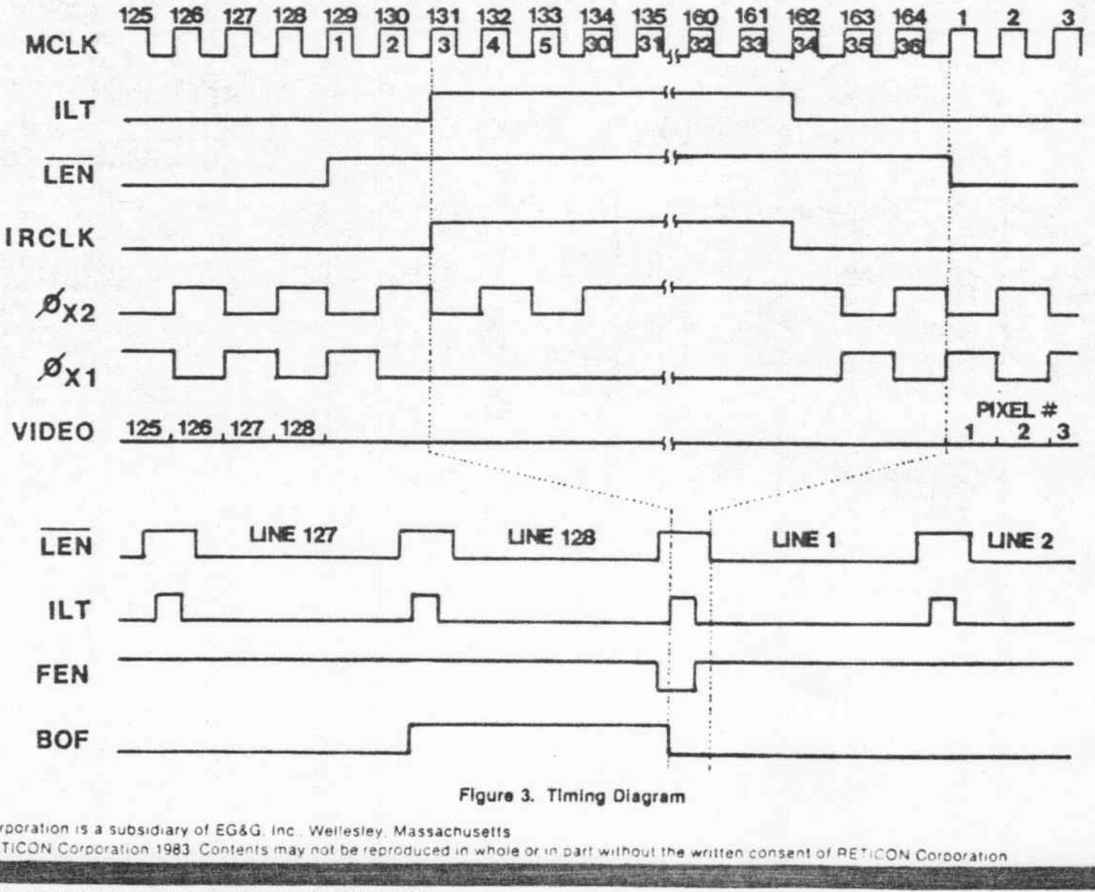

Figure 3. Timing Diagram

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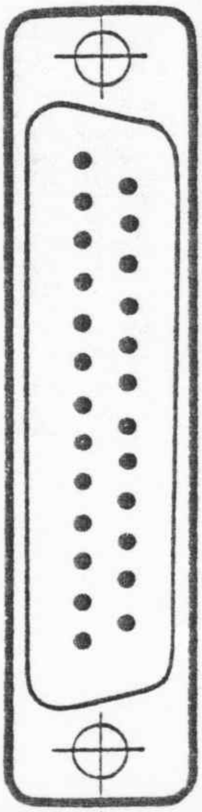
TERMINOLOGY DEFINITIONS

MCLK- - - - - - - - - - - - - - MASTER CLOCK INPUT
CCLK- - - - - - - - - - - - - -CAMERA CLOCK OUTPUT
LT- - - - - - - - - - - - - - -LINE TRANSFER INPUT
ILT - - - - - - - - - - - - INTERNAL LINE TRANSFER (Not Accessable to User)
LEN - - - - - - - - - - - - - - LINE ENABLE OUTPUT
SINH- - - - - - - - - - - - - -START INHIBIT INPUT
LTRD- - - - - - - - - LINE TRANSFER TO ROW CLOCK DISABLE INPUT
FR- - - - - - - - - - - - - - - -FRAME RESET INPUT
FEN - - - - - - - - - - - - - -FRAME ENABLE OUTPUT
RCLK- - - - - - - - - - - - - - - -ROW CLOCK INPUT
IRCLK - - - - - - - - - - - - - INTERNAL ROW CLOCK (Not Accessable to User)
ϕ_{X1}- - - - - - - - - - - - - - - - - - PIXEL CLOCK (Not Accessable to User)
ϕ_{X2}- - - - - - - - - - - - - -PIXEL CLOCK INVERTED (Not Accessable to User)

NOTE: Only MCLK is required for minimum camera operation. Other I/O's required when using additional camera features.

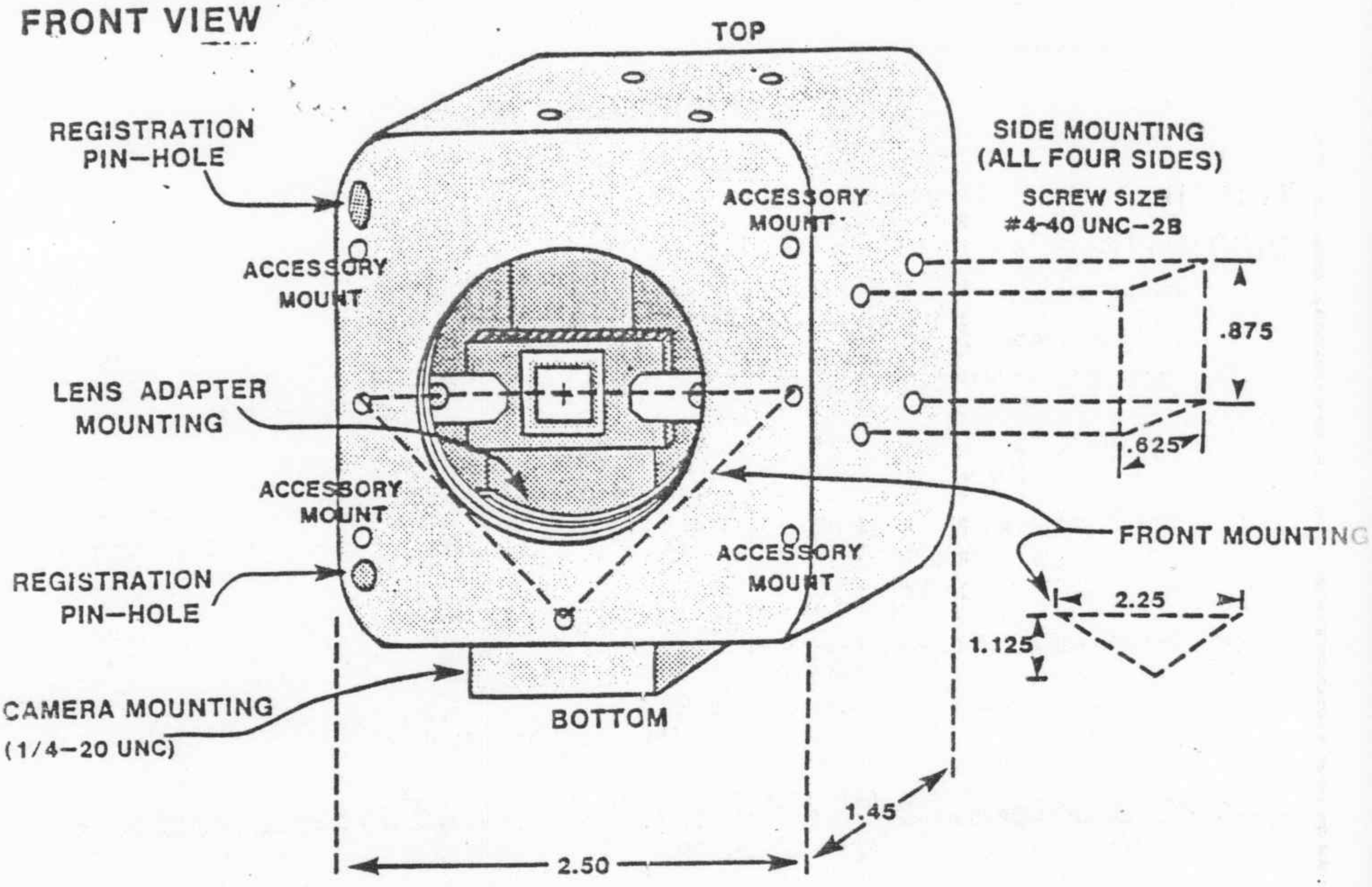
CAMERA CONNECTOR



+12V_{DC} INPUT	13
− VIDEO OUT	12
− START INHIBIT (SINH) IN	11
− LT & ROW CLOCK DISABLE (LTRD)	10
+ FRAME RESET (FR) INPUT	9
+ LINE ENABLE (LEN) OUT	8
+ FRAME ENABLE (FEN) OUT	7
− FRAME RESET (FR) INPUT	6
+ ROW CLOCK (RCLK) IN	5
− MASTER CLOCK (MCLK) IN	4
− CAMERA CLOCK (CCLK) OUT	3
COMMON	2
+5V_{DC} INPUT	1

25	−12V_{DC} INPUT
24	+ VIDEO OUT
23	+ START INHIBIT (SINH) IN
22	+ LT & ROW CLOCK DISABLE (LTRD)
21	− ROW CLOCK (RCLK) IN
20	− LINE ENABLE (LEN) OUT
19	− FRAME ENABLE (FEN) OUT
18	− LINE TRANSFER (LT) INPUT
17	+ LINE TRANSFER (LT) INPUT
16	+ CAMERA CLOCK (CCLK) OUT
15	+ MASTER CLOCK (MCLK) IN
14	COMMON

FRONT VIEW



REAR VIEW